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Bait Preferences and Morphology of The Greater Bandicoot Rat *Bandicota indica* in a Ricefield, Kedah, Malaysia

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Abstract: The greater bandicoot rat (*Bandicota indica*) is one of the largest rodent pests known and has been introduced in Malaysia for nearly 80 years; however, there is a lack of information regarding this species locally. This paper investigates the population status and whether the species has spread beyond its known geographical distribution boundaries. Burrow entrance sizes from Kedah and Perak were compared to evaluate any sign of a new invasion. The greater bandicoot rat population was higher further north of peninsular Malaysia compared to the other state. In term of morphology, the greater bandicoot rat captured from Jitra rice field weighted around 400-500g and have blackish brown dorsal hair colour. Although they were recorded as omnivorous, the greater bandicoot rats responded well towards protein-based bait. Their breeding season was estimated to peak during monsoonal season (Aug-Jan).

Keywords: Agriculture, Burrow Study, Food Security, Rice, Rodent Pest

INTRODUCTION

Rats in Asia consume food crops that could feed an estimated 200 million people for an entire year (Singleton, 2003). In Indonesia, the average annual rice losses are estimated to be 15%. Rodents are identified as the most important pre-harvest pests in economic terms (Geddes, 1992). In Africa, damage due to rodents in Tanzania causes an estimated annual yield loss of around 5–15% (Leirs, 1989), while rodent damage in Malaysia is still manageable, usually ranging from 4% to 7% (Singleton, 2003). *Bandicota* sp. (Bandicoot rats), *Rattus argentiventer* (rice field rat), and *Rattus rattus* (roof rat) are classic examples of rodent pests that have been introduced in many ecosystems and are among the most widespread and problematic invasive animals affecting agriculture lands. Introduced rodents may consume a wide variety of food items, including plants and animals (Sugihara, 1997;), and their diets can shift depending upon a number of factors, including food availability, the chemical and nutritional quality of those food items, and the rodents' competitive ability relative to other animals that coexist in the environment (Ruffino et al., 2011).

Studies on rodent bait preference will increase the chance of bait uptake and trapping success, and thus, the removal of the rodent pest as part of the pest management program. Rodent trapping studies include the efficiency of bait station designs (Sakthivel et al, 2013), bait efficacies (Pitt et al., 2011; Amni et al., 2019; Munawar et al., 2019;), bait effectiveness (Hice & Velasco, 2013), and the rodents' feeding behavior (Chakraborty & Chakraborty, 1999). There are a number of studies that test bait choices in live trapping involving a number of rodent species such as *Rattus rattus* (Mohd-Taib & Ishak, 2021), *Rattus tiomanicus* (Lee & Kamaruddin, 1987), and *Rattus norvegicus* (Amni et al., 2019) in Malaysia

There are more than 200 rodent species in Malaysia, and at least 12 have been identified as commensal pests (Lam et al., 1982; Paramesvaran et al., 2009; Lim, 2015). The rice field rat Rattus argentiventer rodent pests in the rice fields in Jitra, Kedah, as are typical of most rice fields in Malaysia. In addition, two other rodent pests; the Lesser and the Greater Bandicoot Rats (Bandicota bengelensis and B. indica), are found exclusively in the northern peninsular of Malaysia (Lim, 2015).

Physical trapping is the initial step in pest population management, as it allows for proper and correct pest identification. Therefore, studying the bait preferences of the target pest animal will assist in improving their capture rates (Amni et.al., 2019). As an omnivorous pest, bandicoot rats favor a wide range of food sources. Therefore, a study was conducted to explore the bait preferences of the bandicoot rat for a more successful trapping exercise and to assess the population parameters in comparison to other rodent pests.

Dietary study of *Bandicota* sp in Malaysia is recorded as anecdotal observation. In addition, the only information on their diets was recorded back in the 1970s by Lam (1985) from laboratory studies, and there have been no research updates on their feeding aspects since then. This study aimed to explore the status and distribution of the greater bandicoot rat population, and bait preferences, based on assessments of their stomach content. These findings can assist in the evaluation of the impact of *B. indica* and provide a further understanding of the invasive species after more than a decade of documenting its presence in Malaysia.

MATERIALS AND METHODS

Study sites

The research was carried out from July 2017 until February 2021 in a rice field in Jitra Kedah (N˚ 6˚18' 53.17", E˚100˚ 20' 4.85"). Preliminary baiting was conducted in July 2017 and July 2018. The bait preference study starts from December 2019 through February 2020, followed by the population observation study for both main and off season of May 2019 till February 2021. The main rice planting season runs from September to February during the monsoon season, while off-planting occurs during the dry season between March and August each year.

Jitra was described as a rice field with scattered residential areas. A small-scale, farmer-run network of rice fields surrounds the city of Jitra. Generally, there are two rice planting seasons per year: the main planting season (October-February) and the off-planting season (March-September). However, planting activity is highly dependent on the water supply, and sometimes, planting activity during the off-planting season is delayed by a few months due to dry weather and an insufficient water supply.

The second research site used to compare burrow entrance sizes is in Bagan Serai, Perak (5.0081° N, 100.5394° E). Bandicoot rats were recorded to exist in northern states such as Penang Island, Kedah, and Perlis (Lim, 2015), hence, the rice field in Bagan Serai was only occupied by the rice field rats. Therefore, this area is chosen as a site comparison not only because of the absence of bandicoot rats but also to evaluate whether the species has transcended across the border after 80 years of introduction in Malaysia.

Bait Preference Test

Live trapping exercises were carried out at seven sampling sites in Jitra, Kedah (Figure 1). A total of 70 traps were set up, mostly near active burrows to increase the likelihood of capture. The live traps used were the typical cage traps with dimensions of 27cm x 18cm x 13cm. The traps were set at 1700 h and inspected at 0900 h the following day. Seven different types of bait were used: shrimp paste

(SP), dried fish (DF), fried chicken leftovers (FC), fresh prawns (FP), fresh crabs (FC), dried crackers (DC) and rice grain (R). Shrimp paste and dried fish were lightly roasted to bring out the aroma to attract rodents in the vicinity. Fresh prawns and crabs were secured from a local fish market. These fresh sea food products were included as baits in the study as Chakraborty (1999) discovered B. indica fed on crabs apart from freshwater molluscs, the apple snail, Pila glabosa, and the freshwater mussel Lamellidens marginalis occasionally. The rice grains were placed in a small plastic pouch with holes. Fried chicken leftovers and dried crackers were chosen as bait as the greater bandicoot rats were recorded to have a preference for human leftovers in urban settings and had previously used as baits for lesser bandicoot rats in Penang Islands (Amni et al., 2019). Pieces of fried chicken leftovers were collected from a local fast-food outlet. Captured rats were identified according to species, age groups, sexes, while morphometric measurements were recorded and weighed.

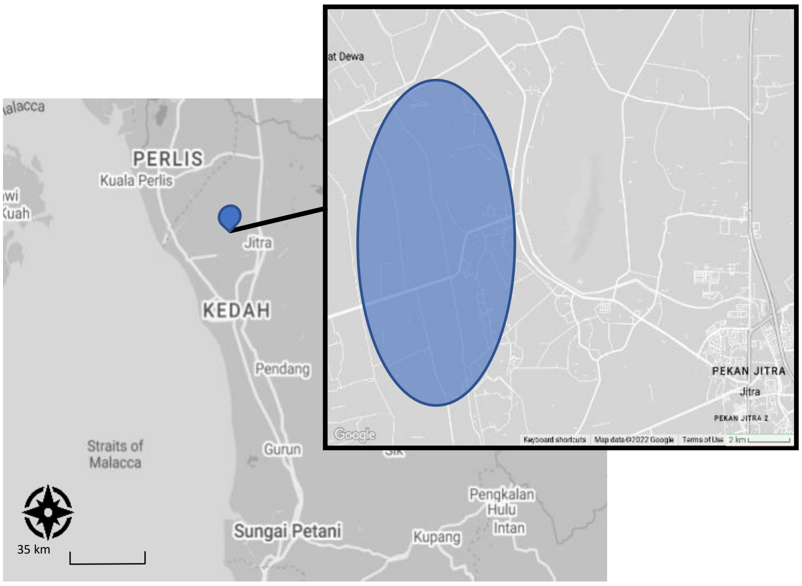

Figure 1. Study sites in Jitra, Kedah. Blue circles indicate study areas in Jitra, Kedah.

Observation on Rodent Population

Population observation was conducted during both the main and off seasons throughout the rice growing stages (Table 1) of the year 2019 until February 2021. For this part of the study, we used shrimp paste and dried fish during the dry season and fresh crabs and fresh prawns as baits during the wet season. Different baits were used during both seasons due to the weatherability of the baits. Fresh crabs and prawns remain on the bait hook due to their hard exoskeletons, whereas shrimp paste and dried fish fall off easily when wet, reducing the efficiency of the traps during the monsoon season. However, the use of fresh baits will attract more insects and ants if applied during the dry season.

60 live traps were installed in the rice field for each 5 rice growing stages: (i) land preparation, (ii)vegetative stage, (iii)tillering stage, (iv)booting stage, and (v) harvesting stage (Table 1). Six randomly placed trap lines were set within Jitra rice field. Each trap line consisted of 10 trap sites (each with one live trap) spaced every 20 m along the line (Gillies et al., 2003). This study involved 2400 nights of trapping efforts; 60 traps x 4 nights x 5 growth stages x 2 planting seasons. The traps were installed in a location with active burrow activities such as signs of fresh burrow digging, fresh foot prints near the burrow entrance (Figure 2), signs of food leftovers nearby the entrance (Figure 2), and signs of rice damage in the rice plots to increase the capture probability.

Traps were also covered with dried grass to avoid capturing non-target animals like birds (Weihong et al., 1999) and provide camouflage from undesirable human activities such as tampering with the traps or stealing. Traps were examined and reset at 0700H on the next day at the same place. They were identified to species level, sexed, weighed, and measured. Rodent handling was done in accordance with the guidelines of the American Society of Mammologists for the use of wild animals in research and education (Sikes et al., 2016). Results were presented as the overall number of captures of rats in each survey (Gillies et al., 2003).

Assessment of active burrows

In all three areas, we conducted a survey, searching for active burrows within the rice field. Burrows were identified as active when there is fresh dug soil at the entrance, visible rat footprints at the entry of the burrow, and the presence of food leftovers such as stalks or snail shells nearby the entrance (Phukon & Borah, 2019). We also conducted an active burrow test, where the selected burrows in an area were recorded, then covered with soil before being left for 24 hours. Burrows with signs of digging the next day were labelled as active. Measurements recorded from the active burrows were height, width, and entrance size. Later, the data on burrow entrance sizes were analysed and compared to evaluate the difference between entrances observed in Kedah and Perak

Data Analysis

A two-way analysis of variance (ANOVA) was used to calculate the difference in rodent capture when using different types of baits. To differentiate between the bait types, a Tukey post hoc test was used. Descriptive statistics were used to express the number of captured rodents per bait, the difference in morphological characteristics, and rodent species distribution and sex composition throughout the main and off-rice planting season. The T-test was later used to compare the composition of species caught over the main or off-planting season. The analysis was performed using SPSS software version 23 (IBM Corp.).

RESULTS

Baiting Test

186 rodent pests from five different rodent species were captured throughout 95 days of trapping nights (December 2019 to February 2020). Five different species were identified. They were the greater bandicoot rat, *Bandicota indica* (61.29%), the roof rat, *Rattus rattus* (19.90%), and a non-rodent; an insectivore Asian house shrew, *Suncus murinus* (12.90%) and the rice field rat, *Rattus argentiventer* (5.91%). The highest number of rats were trapped using shrimp paste (22.94) as bait, followed by fresh prawn (22.35%), dried fish (21.18%), and fresh crabs (15.29%). Rice grain had the lowest trap success rate (3.53%) (Table 1). There was a statistically significant difference between the different types of baits used as determined by a two-way ANOVA ($F= 7.0487$, $df = 6$, $p<0.05$). Multiple mean comparison by Tukey's test revealed that the number of greater bandicoot rats caught was statistically higher with shrimp paste (2.9 ± 0.54), dried fish (2.8 ± 1.51), fresh prawn (3 ± 2.00) and fresh crabs (2.1 ± 1.43). (Table 1).

Table 1: The total number (and percentage) of captures for each rodent pest species with different bait types.

Species	Shrimp paste	Dried fish	Fried chicken leftover	Fresh prawn	Fresh Crab	Dried cracker	Rice
				Family Muridae			
Bandicota indica	*22(19.30)	*19(16.67)	15(13.16)	*33(28.95)	*23(20.18)	-	2(1.75)
Rattus argentiventer	1(9.09)	1(9.09)	2(18.18)	2(18.18)	-	3(27.27	2(18.18)
Rattus rattus	10(27.07)	11(29.73)	4(10.81)	-	-	10(27.02)	2(5.41)
				Family Soricidae			
Suncus murinus	6(25)	5(20.83)	5(20.83)	3(12.5)	3(12.5)	2(8.33)	-

*Indicates significant number of rodents captured when using this bait.

Morphology of The Greater Bandicota Rat, *Bandicota indica*

There are not many differences observed between bandicoot rat from Jitra, Kedah and from Chuping, Perlis in terms of their physical measurements (Shukor, 2018). The bandicoot rats caught in Jitra were also comparable to the species recorded in Chuping and Vietnam (Aplin et al., 2003). The bandicoot rats from Vietnam and Cambodia were found to have darker ventral hair colour (Aplin et al., 2003, as shown in Table 2).

Figure 2: Side view of an adult greater bandicoot rat, note that the prominent hairy bristle on their back. Source: Dr Hasber Salim (USM) and Maisarah Burhanuddin (UPM)

Table 2. Comparison of greater bandicoot rat *B. indica* in this study with other studies that has been conducted.

Parameter and source	This study	Shukor *et al*. (2018)	Aplin *et al*. (2003)			
Origin	Jitra, Kedah	Chuping, Perlis	Vietnam	Cambodia	Thailand	Bangladesh
Head body length (mm)	223.5 ± 45.9 (150-270)	201.09±12.8 (156-280)	231±34.9 (167-300)	175-285	To 276	150-309
Tail Length (mm)	180.9 ± 52.2 (130-270)	180±10.4 (151-252)	196 ±28.6 (147-248)	140-270	To 244	115-267
Hind foot length (mm)	48.9 ± 0.96 (35-63)	43.55 ±1.4 (41-55)	52 ± 4.2 (42-58.5)	40.5-54	To 56	42-60
Skull length (mm)	65.6 ± 13.9 (40-80)	54.63 ±2.0 (50-70)	-	24-29	To 30	-
Weight (g)	407.58±200.99 (70-912)	451.81±57.9 (330-875)	370±191.0 (125-870)	To 830	To 545	To 746
Dorsal Hair colour	Blackish brown	Blackish brown	-	-	-	-
Ventral hair colour	Pale grey	Pale grey	Darker coloration	-	-	-
No. or mammae-pectoral	3 pairs	3 pairs	-	-	-	-
No or mammae-inguinal	3 pairs	3 pairs	-	-	-	-

Active Burrow Size Comparison

A total of 56 burrows were measured at each location. A one-way analysis of variance (ANOVA) was calculated on active burrow height, width, and entrance size. The analysis was significant, with height $F(2, 165) = 23.55$, $p < 0.05$., width $F(2,165) = 21.43$, $p < 0.05$, and entrance size $F(2.165) = 29.32$, $p < 0.05$. We continued the analysis with least significant difference (LSD) mean comparisons to determine precisely which areas have different burrow sizes (Figure 3).

The mean comparison revealed that burrow parameters in Jitra, Kedah were significantly different in terms of height, width, and entrance size when compared to other locations (H= 8.12cm, W=9.94cm, A=267.63 cm2, p<0.05). Larger entrance sizes may be built by larger rodent pest species, in this case, the greater bandicoot rat. Average burrows in Bagan Serai, are smaller when compared with Jitra (H=6.75, W= 6.49, A= 148.94 cm2, p< 0.05).

These may indicate that, smaller size rodent pests are inhabiting the Bagan Serai rice field such as rice field rat Rattus argentiventer. We did encounter an Asian House Shrew (Suncus murinus) in one of our surveys. With smaller burrow entrance sizes on average in Bagan Serai, we concluded that there is currently no evidence of greater bandicoot spreading near the Kedah-Perak rice field area. Although, the greater bandicoot rats were sighted in Yan, Kedah, burrow survey analysis revealed that there is no significant difference when compared with burrows in Jitra. It is contemplated that the greater bandicoot rat population in Yan is very low when compared with the northern parts. We also resolved that; the greater bandicoot rat population is more abundant towards the north of Peninsular Malaysia.

Fig. 3: Entrance size comparison between burrows from (A) Bagan Serai, Perak, (B) Yan, Kedah and (C) Jitra, Kedah. Comparison size with mini measuring tape (size 5cm x 5cm).

Species Composition Throughout Main and Off-Rice Planting Season

The off-rice planting season began in May and lasted until September 2019, after which the main planting season began and lasted until February 2020. The Greater Bandicoot Rat (*B. indica*) was found to be dominant in trapping exercises carried out in comparison to other rodents trapped in the area, followed by the Rice Field Rat (*R. argentiventer*), Roof Rat (*R. rattus*) and Asian House Shrew (*Suncus murinus*). Starting in May, the percentage of greater bandicoot rat trapped (68.09%) exceed other rodent species; *R. argentiventer* (12.77%), *Suncus murinus* (12.77%) and *Rattus rattus* (6.38%). Their number remains consistent throughout both the main and off-rice planting seasons of 2019 and 2020.

There was a significant difference in the scores for comparing rodent pest species throughout the main and off-rice planting seasons (Table 4). Number of *B. indica* (M=67.91, SD= 154.97) was significantly different when compared with *R. argentiventer*, (M=7.5862, SD= 69.82, conditions; $t(38)=17.99$, $p=3.45$ E -20, *R.rattus*, $t(38)=20.84$ $p=2.13$ E-22, and *S. murinus*, (M=21.11, SD= 117.30, conditions; $t(38)=12.68$ $p= 3.13796$ E-15. Aside from that, there was also differences in number of *S. murinus* (M=21.11, SD= 117.30) with *R. argentiventer*, (M=7.5862, SD= 69.82, conditions; $t(38)=4.4223$, $p=7.92$E-05), and *R.rattus*, (M=3.3935, SD= 36.62, conditions; $t(38)=6.0387$, 1.67795E-07) (Table 3).

However, when comparing the number of species in both main and off season, only *B. indica* shows a significant number in year 2020 where *B. indica* during off season 2020 (M=68.1237, SD= 25.0445) and main season of 2020, (M=81.2942, SD= 44.5963, conditions; t (8) =63.5290, 0.0077). There was a significant increase of *B. indica* population during main season of year 2020 (Table 4).

Table 3: T-test result comparing different species throughout main and off rice planting season.

Parameter	n	Mean	SD	t-cal	t-crit	df	p
**B. indica*	20	67.9074	154.967	17.9927	2.0244	38	3.45436 E-20
R. argentiventer	20	7.5862	69.82				
**B. indica*	20	67.9074	154.967	20.8440	2.0244	38	2.13 E-22
R. rattus	20	3.3935	36.6219				
**B. indica*	20	67.9074	154.967	12.6826	2.0244	38	3.13796 E-15
S. murinus	20	21.1129	117.302				
R. argentiventer	20	7.5862	69.82	1.8174	2.0244	38	0.077
R. rattus	20	3.3935	36.6219				
R argentiventer	20	7.5862	69.8201	4.4223	2.0244	38	7.92E-05
**S. murinus*	20	21.1129	117.3024				
R. rattus	20	3.3935	36.6219	6.0387	2.0244	38	1.67795E-07
**S. murinus*	20	21.1129	117.3024				

*Indicates significant number after the p value

Table 4: T-test result comparing number of *B. indica* throughout main and off rice planting season.

Parameter	n	Mean	SD	t-cal	t-crit	df	p
B. indica							
Off 2019	5	61.3201	57.8522	0.0530	2.3060	8	0.9590
Main 2019	5	60.8917	268.7718				
Off 2020	5	68.1237	25.0445	3.5290	2.3060	8	0.0077
*Main 2020	5	81.2942	44.5963				

*Indicates significant number after the p value

DISCUSSIONS

This result shows that the greater bandicoot rats seem to prefer protein-based bait when offered in the live traps. The greater bandicoot rat, *B. indica*, is a classic rodent species that is versatile in feeding behaviour and savours a wide range of foods. Most greater bandicoot rats are reported as pests in agricultural lands and consume a wide range of crops. In India, they were reported to forage in potato fields, green leafy vegetables, gourds, and mask melons (Chakraborty & Chakraborty, 1999). In captivity trials, *B. indica* was found to favour rice, wheat, maize, and groundnuts (Sridhara & Srihari, 1983). However, some of the baits have low weatherability, as they easily fall off the trap hook when the rain comes. In this study we discover that during rainy days, fresh crabs or fresh prawns are recommended as baits. The tough exoskeleton of the crabs and prawns will prevent the bait from falling off, aside from providing a strong smell as an attractant.

The greater bandicoot rat (*B. indica*) population in Jitra rice fields was found to show an interest in baits with a strong and fragrant smell. A study by Saarani et al. (2021) in Kedah successfully captured several *B. indica* using bananas as baits. It is recommended to use dried grass as trap cover because it not only aids in successful capture but also provides camouflage against accidental stealing and prevents the trap from capturing non-target animals, such as birds. Aside from dried grass, other materials used to cover rodent traps include transparent plastic, wire netting, and galvanised iron (Weihong et al., 1999). Another factor to be considered before installing the trap is the existence of fire ants (*Solenopsis* sp.) nearby the burrows. Fire ants will cause the traps to be ineffective as they will be attracted to the baits, and reducing the probability of rats approaching the traps.

We discovered that the monsoonal season is associated with a greater bandicoot rat breeding season because pregnant *B. indica* females and individuals foraging with them were frequently observed and sometimes captured during these times. At least four pregnant females were captured in our study during monsoonal season, and several of them were found roaming around with young litters over the rice bunds and roadways at dawn, all in the rainy season. This may indicate that the peak breeding season of the greater bandicoot rat is during the rainy planting season (Thitipramote et al., 2009), aside from their ability to reproduce all year round. However, the low captured number of females may suggest that they are more elusive and careful towards traps than males, and pregnant individuals or those with babies that are nesting might avoid being captured by remaining underground. The result was found to be nearly similar to Leirs (1989) observation of the Natal Multimammate mouse (*Mastomys natalensis*) in correlating the breeding season of the species with rainfall; the m. natalensis was found to breed in the rainy season at the end of the year in Tanzania. Future burrow study and observation during these periods may result in the discovery of pregnant females or with young litters.

Their preferences for fibrous crops led to their presence in wheat fields (Singal & Pasahan, 1993; Sheikher & Malhi, 1983), sugarcane (Tariq et al., 2017), sorghum, ground nuts, potato (Hussain et al., 2016; Chakraborty & Chakraborty, 1999), legumes (San & Sein, 2019), fodder crops (Siddique & Arshad, 2003), and even in poultry farms (Mehmood et al., 2011). In the field, bandicoot rats can be found throughout the year. However, the attack is usually severe during the booting and maturity stages (Birah et al., 2013; Siddique & Arshad, 2003). Traces of bandicoot rats can be detected with the development of burrow holes with wheat stalks and wheat ears at the entrance (Sheikher & Malhi, 1983; Hossain and Khalequzzaman, 2002; Maqbool et al., 2011).

On average, 2kg of wheat can be found in the food chamber per burrow, and 10.5g of crop straws and grain-filled panicles can be found stored per burrow system (Hussain et al., 2016). The greater bandicoot rat population abundance varies throughout the year and was discovered to use a similar strategy to the rice field rat in synchronising reproduction with rice crop phenology. Fortunately, there was no new sign of invasion towards nearby states, such as Perak, although there was a new record of their occupancy discovered in Sabah (Gait, 2018). Therefore, frequent monitoring by other states nearby Thailand and Kedah border is encouraged to avoid any new invasion of the species.

As a control, the decision to destroy nests should be considered after determining how rodents recolonise when population densities are higher. It can be conducted using a telemetry study (Saarani et al., 2021). For instance, in Vietnam, Brown (2005) concluded that the removal of rice field rats during a low-density phase in an intensive cropping system in Vietnam did not induce movements of neighbouring rats towards the removal area; instead, rats on non-removal areas were moving randomly with regard to directions, and they believed that for *R. argentiventer*, population recolonization events during low-density phases occur through random dispersal events (classical diffusion). As a result, efforts to destroy rat burrows along channels and bank habitats during the later stages of crop growth (after the maximum tillering stage of rice) may be futile because the rats were already primarily utilising the rice crops (Brown et al., 2005). In this case, the control should be conducted before the growing stage, where the movements after the removal event are being conducted.

Predator preservation is a must to avoid exponential population growth in the future. Even though the method to capture the greater bandicoot rat was developed, the damage caused by rodents was reported by local farmers to be decreasing each year since 2019 after trapping sessions when compared to other rice pests such as army worms or brown planthoppers. During the study, several predators were recorded, including the javan mongoose (*Herpestes javanicus*), barn owls (*Tyto alba*), black shouldered kites (*Elanus exillaris*), changeable hawk eagles (*Nisaetus cirrhatus*), brown rat snake (*Ptyas fusca*), black cobra (*Naja* sp.), and king cobra (*Ophiophagus Hannah*). These predators may play roles in suppressing the rodent population in the rice field. Nest box installation, along with regular maintenance, monitoring, and reduced use of unauthorised rodenticides, should help to stabilise the predator population in the area. Future studies on exploring and developing conservation model for other predator candidates is a must.

CONCLUSION

Even though, the greater bandicoot rats were classified as omnivores, in this study, the greater bandicoot rats were attracted to and easily captured using protein-based bait. Covering the traps, installing them near an active burrow, and during land preparation stage give a better capture probability for the species. Monitoring and control of rodent pest populations should be enforced diligently to avoid any new invasion records of this species in other states in Malaysia to secure agriculture and food production. Future study should explore further details on the ecology of the bandicoot species, greener options on managing the rodent pest in rice fields, more comprehensive burrow studies, and population monitoring across states, as well as exploring other natural predator candidates other than the barn owl (tyto alba) and how to manage them effectively in agricultural lands. A proper Integrated Pest Management (IPM) can be generated by combining proper timing of physical trapping, mindful application of appropriate rodenticide, and sufficient predator occurrences in the rice field to control the greater bandicoot rat population from terrorising the rice field in Jitra, Kedah.

Patents

Not applicable.

Author Contribution

Conceptualization, M.B., H.M.N, H.S., N.A.A, S.J., B.A.; methodology, M.B., H.M.N, H.S., N.A.A, S.J., B.A.; software, M.B.; validation, H.M.N, H.S.,S.J., B.A,,N.A.A.;and.; formal analysis, M.B.,H.M.N., investigation, M.B.,H.M.N.; resources, M.B.,H.M.N.; data curation, M.B.; writing—original draft preparation, M.B.; writing—review and editing, H.M.N, H.S.,S.J., B.A,N.A.A.;visualization, M.B.; supervision, H.M.N, H.S.,S.J., B.A.; project administration, M.B.,funding acquisition, M.B., H.M.N

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